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PHYSIOGRAPHIC NOTES.

BY

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USE OF CERTAIN PHYSIOGRAPHIC TERMS.—In the *Journal of Geology* (Vol. X, 1902, pp. 77–111) Professor Davis makes a characteristically clear and convincing plea for more careful usage of the terms base-level, grade, and peneplain. By quotations from the writings of numerous authors he shows that *base-level* is given very different meanings by different writers:

> These meanings are: an imaginary level surface in extension of that of the ocean (the convex geoid surface); an imaginary mathematical plane; an imaginary surface, sloping with the mature or old streams of its area; the lowest slope to which rivers can reduce a land surface; a level not much above that of the sea; a slow reach in a stream; a condition in which rivers cannot corrade, or in which they are balanced between erosion and deposition; a certain stage in the history of rivers when vertical cutting ceases and their slope approximates a parabolic curve; an ultimate planation, and a plain of degradation.

Professor Davis points out the desirability of associating the term base-level with only one of these meanings, and suggests the limitation of the term to that meaning, and to define it *as the level base with respect to which normal subaerial erosion proceeds;* to employ the term *grade* for the balanced condition of a mature or old river; and to name the geographical surface that is developed near, or very near, to the close of a cycle, a *peneplain*, or *plain of gradation.* It is believed that most physiographers will see the desirability of thus limiting these terms.

As Professor Davis says, his article is more than a plea for names. Among other things it contains an excellent and very clear discussion of the complex subject of *grade*, as applied to land reduction. He says that

> the balance between erosion and deposition, attained by mature rivers, introduces one of the most important problems that is encountered in the discussion of the geographical cycle. The development of this balanced condition is brought about by changes in the capacity of a river to do work, and in the quantity of work that the river has to do. The changes continue until the two quantities, at first unequal, reach equality; and then the river may be said to be graded, or to have reached the condition of grade. . . . In fine, grade is a condition of essential balance between corrasion and deposition, usually reached by rivers in the mature stage of their development, when their slopes have been duly worn down or built up with respect to the base-level of their basin.

With regard to the nature of the grade thus established Professor Davis says:

> The actual slopes of the different parts of a graded river system vary from a faintest declivity in the lower course of the trunk river to decidedly steeper declivities in the uppermost courses of the headwater streams.

One of the most important parts of this article is the extension which Professor Davis makes of the use of the idea of an establishment of grade from the stream-course itself to the hillsides. He had previously brought this point forward, but the present article contains an excellent statement of this very important idea. The point is that, wherever the land is wasting away, there is a cycle of development in progress, and that the course pursued in this development is essentially the same in the streams of waste which are moving down the hillsides toward the rivers as in the rivers themselves. The tendency is to establish a grade in the main stream, for this to extend up the tributary streams, and to continue along their numerous subdivisions until the entire area between the stream and its divide has attained a condition of established grade.

Employing the term *waste-streams* for the slow hillside movement of soil, Professor Davis compares their development to that of rivers, as follows:

> The first development of the balanced or graded condition in waste-streams usually takes place on the outcrops of the weaker rocks that are exposed on freshly-cut valley sides. Here graded waste slopes are locally developed; the adjoining waste-streams form a sheet or cloak of waste which creeps slowly down the slope, while untamed ledges of harder rocks are still kept bare by the removal of waste from their surface as fast as it is formed. These represent the falls and rapids of water streams, because the waste from above the ledges passes over them quickly; while the graded waste-covered slopes represent the graded reaches of water streams, where the movement is more regular and leisurely. The less resistant of the bare ledges are the first to retreat under cover, permitting the grades below and above to unite in a single continuous slope; and so on until all ledges are concealed under a graded sheet of waste, and the sharp, vigorous forms of youth and early maturity merge into the subdued and tamed forms of passing maturity and approaching old age. During the progress of this change there may be abundant examples of captures of one group of waste streams by the leading members of another group, especially in regions of tilted strata; thus increasing the resemblance to waste-streams and water streams until one is tempted to regard the difference between them as one of degree rather than of kind. . . . It is always with reference to the graded course of the main river that the side streams are graded; it is with reference to all the graded streams that the slopes of the interfluves are graded.

As Professor Davis himself says, it is more doubtful whether physiographers will accept his proposition regarding the usage of the terms denudation and degradation than the other points that he raises. Yet, notwithstanding the entirely new meaning which he proposes for these terms, there is something very attractive in his suggestion. Moreover, by the usage which he proposes there will be a distinct relation between the meaning of the words and their applications to physiographic phenomena. His proposition is as follows:

> Denudation might be advisedly used as the name of those active processes, chiefly operative in the youth and maturity of a cycle, by which rock structures are laid bare, literally denuded, because their waste is removed as fast as it is formed. Degradation, on the other hand, is more appropriately associated with those leisurely processes, characteristic of the later stages of the cycle, in which a graded slope is reduced to fainter and fainter declivity, although maintaining its graded condition all the while. Aggradation is naturally the opposite of degradation, and implies the deposition of rock waste by transporting agencies, the built-up surface being always kept essentially at grade. Thus defined, denudation would accompany the early work of downward corrasion by streams, and the longer-lasting work of valley widening by weathering and washing. It would be systematically transmuted into degradation as the processes that operate on the various lines of down-slope streaming attained the graded condition—the large rivers first, the smaller branch streams later; the head-water streamlets and the hillside waste-streams later still. Retreating cliffs and summit ledges, the last strongholds of denudation, would pass into the phase of degradation when they are reduced under the graded waste-cover in the stage of subdued relief, characteristic of late maturity and early old age, and thenceforward all further erosion would be by degradation alone.

Nearly every point in this article by Professor Davis is worthy of the most careful attention of physiographers, and cannot help having a very decided influence in establishing a more careful usage of the terms discussed, besides clearing up from the minds of many those difficulties in the interpretation of facts which have arisen partly through a lack of consistent usage of these common and now well-established terms.

GEOLOGY OF NORTHEASTERN LABRADOR.—In a paper describing the results of a summer excursion to Labrador (*Bull. Museum Comparative Zoology*, Vol. XXXVIII, pp. 205–270), Dr. R. A. Daly makes the following statement regarding the mountains of the extreme northeastern part of Labrador between Ungava Bay and the ocean:

> The Torngats afford a field of operations which it will take many seasons even to reconnoitre. In the last-mentioned range are the highest mountains on the Atlantic seaboard of America, unmeasured and almost entirely unnamed. It would be of much importance to fix the elevation of the highest post-glacial shore-line in the interior of the peninsula as well as on the south coast, in Newfoundland, Cape Breton, and across Hudson's Strait, where isolated observations have already been made.

This remark is less true than it was before Dr. Daly's paper was published, for he has given us some important results upon the geology and geography of the Labrador coast, including some important observations in the Torngat mountains.

Daly shows that there are evidences of marked glacial erosion on the Labrador coast, and some of the hanging valleys are described and pictured. His descriptions of certain of the fjords, and the interpretation which he places on their history, are among the best that have been given for the northeastern American coast. Daly also brings forward facts to prove the earlier conclusion of Lieber and Bell, that these lofty mountains rose above the ice-sheet of the Glacial Period. No erratics could be found above an elevation of 2,050 feet; but below this level there has been vigorous glacial erosion, proved by erratics and other forms of glacial deposits, roches moutonnées forms, and other signs of glacial erosion. His conclusion on this point he states as follows:

> Taking the Nachvak region as a sample of the whole of the higher Torngats, the general conclusion is that these mountains have not suffered, during the last advance of the ice-cap, even the limited amount of glacial erosion that may be discerned on the summits of Mt. Ktaadn, the Presidential range of New Hampshire, Ben Nevis and the neighbouring peaked mountains of the western Scottish highlands, or the ragged outliers of the Scandinavian plateau. It is probable that the higher parts of the Kiglapait and the Kaumajet massifs similarly formed nunataks overlooking the late Pleistocene ice-sheet.

Another important feature of Daly's paper is his discussion of the evidence of post-glacial uplift of the land. This he finds to have been differential, the level of the highest marine work between St. Johns, Newfoundland, and Nachvak, in northern Labrador, varying from 575 feet at St. Johns to 250 feet at Nachvak. At Hopedale, more than two-thirds of the way from St. Johns to Nachvak, the highest marine work stands at 390 feet. Daly says that

> Hamilton Inlet owes in part its depth, and, indeed, its very existence as an inlet (it is but 10 fathoms deep at the Narrows), to the fact that the part of the plateau on which it lies has not been elevated as much as the land to north and to south.

Regarding the differential uplift, Daly reaches the following important conclusion:

> If the record of the table be put in graphic form it becomes still more evident that along the eleven hundred miles of coast the elevation has been differential. The pronounced warping of the highest shore-line is incompatible with the view that changes in the position of the level of the sea over great stretches of the earth's surface are produced solely by independent vertical movements of the surface of the ocean. Along the line on which our observations were made there has been unequal positive uplift of the earth's crust. The force responsible for this great piece of work has been applied locally and in varying degree. The result is that to-day the actual distance from the centre of the earth of every point on that line is greater than it was at the close of the glacial period.

One of the interesting suggestions made by Daly is that the elevation in both Labrador and Newfoundland is still in progress. This suggestion is based upon the almost universal evidence of old settlers, who are of the opinion that, during periods of thirty to sixty years, rock ledges have come perceptibly nearer the sea surface, while new channels among the shoals have to be sought by the fishing boats. When, over one hundred and fifty years ago, similar evidence was offered for the coast of the Scandinavian peninsula its value was questioned; but the placing of bench marks has proved the correctness of the evidence, and the changes of level on the Scandinavian coast are now classical in geology. In order to understand the meaning of these movements of the earth's crust, it is highly important that we have other definite records in various parts of the world, and northeastern America seems to offer opportunities for this kind of observation. I wish, therefore, to add my opinion to that of Dr. Daly that this is a direction in which there is an opportunity for valuable work. It would stand to the credit of the American Geographical Society if it should undertake to lay a foundation for future study of this interesting problem.

LOESS OF NORTHERN CHINA AND CENTRAL ASIA.—The work of Richthofen and Pumpelly attracted such attention to the remarkable deposits of loess in China that any further work upon this subject will be of interest. In his recent trip across the loess country Professor G. Frederick Wright has made some observations and drawn certain conclusions which have recently been published in the *Bull. of the Geological Society of America* (Vol. XIII, pp. 127–138, 1902). Professor Wright looked in vain for evidences of extensive glaciation, and the absence of such evidence leads him to conclude that the Chinese loess cannot be ascribed to fluvio-glacial origin, as has been suggested. The presence of boulders and gravel beds, and the existence of apparent terraces, have led him to the conclusion that the

> present distribution of loess over northwestern China was mainly secured by the agency of gradually-receding water, the presence of which would be obtained by a temporary general depression of the land about 3,000 feet.

It is his opinion that a vast area, extending from the Black Sea almost to the Pacific, and reaching from the Arctic to below the Caspian, was submerged for a brief period during the latter part of the Tertiary, possibly contemporaneously with the uplift of northwestern Europe and northeastern America. That Professor Wright does not entirely discard the agency of the wind is shown by his closing sentences, as follows:

The discussion should not be closed, however, without remarking that ample credit must still be given to the wind as an agency which is still at work distributing the loess and producing many minor modifications which are plainly visible in northeastern China, where many of the extensive deposits are clearly drifted material brought in by the wind in recent times. This may be freely granted without admitting that wind is competent to account for all the phenomena presented.

ORIGIN OF ESKERS.—The origin of these interesting forms of deposit, associated with the retreat of the continental glacier, has given rise to much discussion. Two explanations stand prominently before glacial geologists, one accounting for them as subglacial stream beds, the other explaining them as deposits in ice gorges on the surface of the glacier. The latest contribution to this discussion by Professor W. O. Crosby (*American Geologist*, Vol. XXX, pp. 1–39), while admitting the probability that eskers are in some cases due to deposits in subglacial streams, argues against this hypothesis as a general explanation, and brings forward facts and arguments for the superglacial hypothesis. Crosby's article ranks with Stone's monograph (The Glacial Gravels of Maine, etc., Monograph 34, United States Geological Survey) as one of the most important American contributions on the subject of eskers.

Crosby shows that existing glaciers and ice-sheets throw very little light on the question. He then states the characteristics of eskers, and follows this with a consideration of the probable condition of the ice-sheet during the formation of eskers. His view on this point is briefly stated in the following summary:

> To summarize, it appears probable that eskers were formed in connection with the sluggish or wholly stagnant marginal portion of the waning ice-sheet, after the liberation by basal melting of all that part of the ground moraine, including drumlins, showing evidence of having been pressed down and compacted by the movement as well as by the dead weight of the ice; and after the upper part of the englacial drift had become superglacial through the superficial melting or ablation of the ice. Such crevasses as may have survived the cessation of flow, or resulted from local subsidence due to basal melting, were probably closed by drift washed into them from above. The general absence of modified drift, interstratified with the till, is an indication that subglacial streams or a concentrated flow of subglacial waters did not exist before the ice became stagnant, the only explanation that suggests itself being that while the ice was in motion it would cause the drift to rise and fill any channel opened above it—a principle which is not operative beneath alpine glaciers (and possibly not beneath the Malaspina glacier), because they have long since swept their channels free of drift.

This preliminary statement is followed by an extensive discussion of the two leading hypotheses, the result of which may be inferred from the following:

> Although recognizing, as previously stated, that other explanations, such as the filling of abandoned channels by surface slide and wash, are entitled to some consideration, and that they are all, probably, essential to the complete theory of eskers,

it is proposed in what follows to take account only of the two main hypotheses, viz., that eskers have been formed by the active agency of subglacial streams, or of superglacial streams. And here, again, as already noted, it is merely a question of relative importance, since I hold with Davis and other advocates of the subglacial hypothesis that neither can wisely be discarded *in toto*. Subglacial tunnels are a reality at the present time, and were, doubtless, to some extent a feature of the Pleistocene ice-sheet; and it would certainly be hazardous to deny that deposits formed in them have never escaped obliteration on the disappearance of the ice.

While this is the strongest argument in favor of the superglacial origin of eskers, there are some points in the discussion to which many glacial geologists will not agree. The chief objection to the superglacial hypothesis is the fact that it requires the existence of a large amount of englacial drift—far more than seems possible from the evidence that has been brought forward. Another objection is the question whether, if superglacial eskers were formed, they could be lowered to the ground on the melting of the ice in the manner which Crosby proposes.

PLEISTOCENE GEOLOGY OF WESTERN LONG ISLAND.—The first published results of the work on the Pleistocene geology of eastern New York, which Professor J. B. Woodworth has undertaken for the State, appears (*Bulletin 48*, *New York State Museum*) under the title of "Pleistocene Geology of Portions of Nassau County and Borough of Queens." The discussion of the Pleistocene history of a section so near the City of New York possesses more than ordinary interest. The paper gives detailed descriptions of the glacial deposits of the section, and is illustrated by maps, photographs, and drawings. In brief summary, the history of the region is as follows: Relatively early in the Glacial Period western Long Island received a thick coating of gravels and sands, some of them borne from the mainland on the north. Somewhere near the middle of this period there was an actual invasion of ice, either floating ice or land ice, laying down beds of till. These deposits are apparently to be correlated with the Columbia formation of McGee. It is not certain just what the level of the land was at this time, but after the deposition of these beds they appear to have been somewhat dissected by stream action,
indicating an epoch of deglaciation or ice retreat of indefinite duration.
Two lines of moraine were then laid down, the outer or more southern one being the earlier. At the time of this moraine formation the elevation of the land above sea-level appears to have been as high, if not higher, than at present;
and during the retreat of the ice one or more temporary lakes existed back of the moraine, first at 80 feet above the present sea-level, then possibly at about 40 feet.

The period of morainic formation and accompanying lacustrine areas is correlated with the Wisconsin or last glacial epoch. After this the ice withdrew across East River, and since that time Long Island has been free from direct influence of the Glacial Period.

Certain features of detail are also explained in Woodworth's paper; for example, the small lakes and tarns, such as Lake Surprise. Some of these exist in the moraine, and in some cases the depressions are evidently due to the melting out of ice blocks left in and under the glacial deposits. The streams of the Long Island plain flow in courses which were carved out by

vigorous glacial streams or in still older channels on the north side of the moraine. Owing to the porosity of the glacial gravels, much of the rainfall soaks into the ground and issues near sea-level in the form of springs; hence, since the run-off is small, little erosive work has been accomplished in the post-glacial epoch.

Woodworth infers post-glacial subsidence from the fact that there are no wave-cut terraces, as one would expect, behind the barrier beaches. He believes that they have been carried below sea-level by subsidence. Beds of peat suggest the local depression of the shore-line.

The features summarized above are fully developed in the paper, and an accompanying map shows in detail the distribution of the glacial deposits. This paper will not only be of interest to students of glacial geology, but also of much use in the schools of the Borough of Queens and vicinity.

PLEISTOCENE GEOLOGY OF WESTERN NEW YORK.—A recent paper by Fairchild (20th report of the New York State geologist, 1900, pp. 105–139) describes and maps a portion of the Iroquois shoreline and gives facts, with numerous illustrations, concerning the overflow channels connected with the withdrawal of the ice-sheet from northern New York. These channels, as recognized by Gilbert, have an important bearing on the detailed history of the glacial lakes which existed in New York while the ice-sheet dammed the present outflows.